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ABSTRACT

Previous economic models suggested that, due to the high channel capacity of cable technology and its capability of pricing television programs directly to the viewers, its diffusion would promote specialized "narrow appeal" programming designed to serve relatively small audience segments. While this has clearly occurred, these models do not account for other developments, such as cable's function as an aftermarket or foremarket for increasingly expensive dramatic programming, the frequent repetition of programs on cable, and the extreme contrasts in audience sizes and production budgets that characterize cable and broadcast programs. This paper summarizes relevant data and then offers a modified "program choice" model in order to explain these phenomena. In this version, decision-makers not only select among program types, but can vary production expenditures and exhibit programs more than once. Under these assumptions, direct pricing mechanisms and new channel capacity are shown to induce a monopoly cable operator not to fragment audiences by offering more specialized programs, but to increase production investments for "mass appeal," "lowest common denominator" programs. Twelve figures are included, and a discussion of the effects of a shift from advertiser to pay support on continuous demand and production functions is appended. (14 references) (Author/EW)

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"NARROWCASTING" ON CABLE TELEVISION: A PROGRAM CHOICE MODEL

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ABSTRACT

Previous economic models suggested that the diffusion of cable technology, due to its high channel capacity and means to price television programs directly to viewers, would promote specialized, "narrow appeal" programming designed to serve relatively small audience segments. While this has clearly occurred, these models do not account for other developments: cable's function as an aftermarket or foremarket for increasingly expensive dramatic programming, the frequent repetition of programs on cable, and extreme contrasts in audience sizes and production budgets which characterize cable and broadcast programs.

This paper summarizes relevant data and then offers a modified "program choice" model in order to explain these phenomena. In our version, decisionmakers not only select among program types, but can vary production expenditures and exhibit programs more than once. Under these assumptions, we show how direct pricing mechanisms and new channel capacity may induce a monopoly cable operator not to fragment audiences by offering more specialized programs, but to increase production investments for "mass appeal," "lowest common denominator" programs.

I. INTRODUCTION

From the 1950's to the mid-1970's, several authors offered economic models which attributed the apparent tendency of broadcasting to offer "mass appeal," "lowest common denominator" programming to its limited channel capacity and its dependence on advertiser support (Steiner, 1954; Rothenberg, 1962; Spence and Owen, 1975; Owen, Manning and Beebe, 1974; Beebe, 1977). This literature suggested that the diffusion of cable or other video technologies with high channel capacity and the means to price television programs directly to viewers would increase the supply of specialized, "narrow appeal" programming designed to serve relatively small audience segments.

The FCC and the courts took several deregulatory steps in the 1970's and early 1980's which paved the way--with spectacular assistance from satellites and other broadband hardware--for cable and other alternative video technologies to prosper. From a collection of 12 to 20 channel systems serving 9% of U.S. households in 1971, cable penetration had come into nearly half of all U.S. TV households by mid-1988, the majority of subscribers served by 20 to 54 and even larger channel systems. Following a brief summary of empirical evidence relevant to cable's performance as a "narrowcaster," this paper offers an alternative model to explain that performance.

II. CABLE TELEVISION'S PERFORMANCE

The current existence of some 70-odd nationally-distributed cable networks testifies for itself to an extraordinary increase in the quantity and diversity of programming which cable technology has made possible. A one-third average viewing share for all cable-originated networks and superstations in cable households in 1987 demonstrates the major audience diversion which has accompanied this increase (A. C. Neilsen Co., 1987). A content and audience analysis of 37 nationally-distributed cable networks (26 basic, including superstations, and

11 premium) as of 1986 by the present author and August Grant (1988) furthermore found 71% of basic cable hours and 19% of premium hours to be original, or "first run," (receiving their first exhibition on cable).[1]

These data omit, however, significant aspects of cable's performance not addressed by previous models. One is the economic importance of cable's function as an aftermarket or foremarket for relatively expensive programs, mostly dramatic series and movies, which often accumulate very large audiences on several different media over time. Our 1986 study found that all dramatic format programming accounted for 24% of hours and 38% of viewing on the 26 basic networks in the sample, and 84% of hours on the 11 premium networks.[2] Relatively very few hours of this dramatic programming, however, (5% on basic cable, 7% on premium), received their first exhibition on cable; nearly all had already appeared in U. S. theaters or on commercial broadcast media. Many of cable's first run dramatic programs, (eg, "made-for-pay" movies) later find their way to independent broadcast stations as well. There further appears to have been substantial budget inflation in these "tiered" dramatic programs during the recent period of cable's growth. Average production costs of MPAA member-produced theatrical features, for example, reportedly increased in CPI-deflated terms by 59% between 1980 and 1987 (MPAA, 1987).

Another characteristic of cable television is the relatively small audiences most of its original productions attract. Average audience size for originally produced cable programs on the 16 basic cable networks in our sample for which audiences were retreivable by Neilsen was about one-quarter that of original PBS-distributed programs (a .7 average minute rating v. 2.8 for PBS), which in turn averaged just over a third that of the broadcast networks (8.1). Average ratings for programs on at least another 11 basic networks were no higher than .1 to .2, however.[3] Part of these contrasts in average ratings might be accounted for by another interesting feature of

cable television: the relatively high frequency with which many programs are repeated on cable. While commercial broadcast stations typically exhibit a program two to four times, producer contracts with both basic and premium cable networks (at least for drama programs) often call for 12 or even more repeats.

Viewership levels are inevitably related to production budgets. Spending for all programs, original and acquired, by all basic networks combined in 1986, including superstations, were estimated by Paul Kagan Associates to be $576 million. Assuming the distribution of basic cable viewing to reflect the distribution of program expenditures, spending on original basic cable productions was something more than half that amount.[4] In comparison, total programming and production expenditures in 1986 for public television licensees alone were $412 million--an amount in turn dwarfed by the several billion dollars spent by the three commercial networks (Corporation for Public Broadcasting, 1988). Notwithstanding repeat rate differences, it is clear that production budgets for original basic cable programs are relatively very low on average.

We offer below a modifed version of the discrete "program choice" models developed by previous authors which attempts to better account for phenomena such as the "tiering" of dramatic programming by cable networks, budget inflation of that programming, increased program repetition on cable, and the contrasts in viewership and program budgets we observe.

III. THE MODEL

We make the following assumptions:

(1) All potential viewers are divided into two groups of size N_1 and N_2. The viewers within each group have identical demands.

(2) There are 3 program types or "subject matters", A, B and D, where:

$V_{1A}(c_A)$ = value of program A to group 1, *etc.*; c_A is production investment in program A, *etc.*

These demand functions are shown in Figure 1.

Figure 1

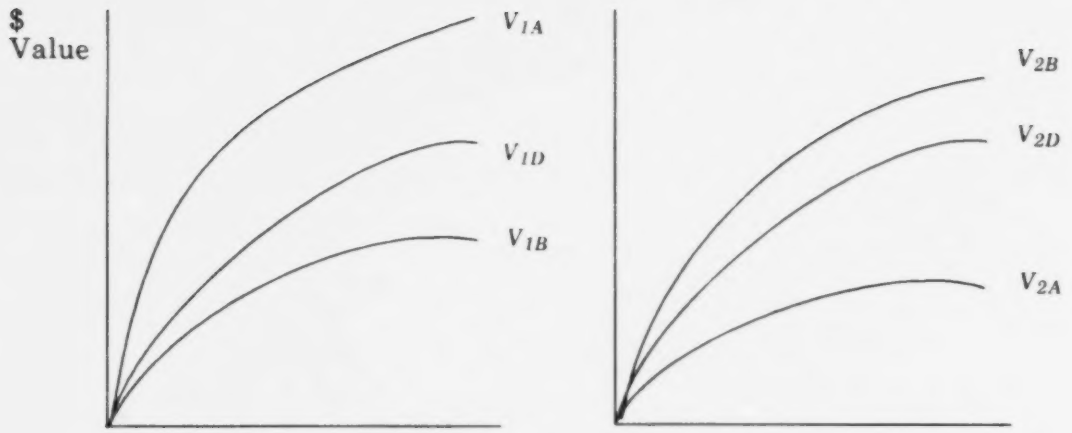
General Program Choice Model

Program Types	Viewer Groups N_1	N_2
A	$V_{1A}(c_A)$	$V_{2A}(c_A)$
B	$V_{1B}(c_B)$	$V_{2B}(c_B)$
D	$V_{1D}(c_D)$	$V_{2D}(c_D)$

For all programs, $V'(c) > 0$; $V''(c) < 0$. That is, an increase in production investment level for a program of a given type increases its value to all viewers, but at a decreasing rate. We further assume that $V_{1A} > V_{1D} > V_{1B}$ and $V_{2B} > V_{2D} > V_{2A}$ for all c, as illustrated in Figure 2. Program D, then, is a "lowest common denominator" program, which for any given c, neither group prefers.

In this model, "program type" has a different interpretation than in previous models. In Beebe's (1977) version, for example, viewers choose among given generic program types (*e.g.*, "action adventure drama," "public affairs", *etc.*), each of which happen to cost a certain amount to produce. In our version, viewers make choices along two separate dimensions: a program's "subject matter" (a term we will interchange with "type"), and the level of investment in that program. Viewers, that is, have distinct preferences as to program subjects, but may be persuaded to watch a program of any type if the investment level is sufficiently high. That is, more movie stars, car crashes or other expenditures of economic resources, human or material,

Figure 2



can persuade viewers to watch a program whose subject matter they would otherwise not select. The value functions simply define how those tradeoffs differ within each group.

A program might have, for example, "action/adventure" subject matter, while the level of investment could reflect whether Harrison Ford or an unknown is the star. Or, subject matter choice might be "street gangs in New York." Investment level in this case could represent whether the program is talking heads among local bureaucrats, a documentary segment on CBS' "60 Minutes," or even a multi-million dollar feature film called "West Side Story." Selection of "subject matter" labels is of course arbitary. On a conceptual level, however, they resolve a nagging ambiguity in traditional models; "subject matter" offers a meaningful interpretation of what is meant by "narrow appeal" vs. "broad appeal" types of programs; breadth of appeal can be defined, that is, as the proportion of total audience which alternative programs can attract at some given production cost level.

(3) There is an alternative activity (say a VCR) whose value for all viewers is defined by t, such that viewers will only watch program types A, B, or D if $V(c) > t$ for that program.

(4) A single firm operates the television system.

The assumption of monopoly rather than competition is limiting, as discussed below, but appropriate to the cable industry. Local cable systems have negligible competition from other cable systems and arguable monopoly power with respect to broadcast stations, VCR's, and other media.

The system operator, as the industry gatekeeper, effectively has two decision variables which correspond to the arguments of the demand function: selection of program subject matter, and the level of investment in the program. Our objective is to compare the firm's optimal choice of program types and investment levels under advertiser versus pay support and under limited versus unlimited channel capacity. To reduce the complication of this task, we employ some simplifying assumptions as follows: First, let V_{1B}, $V_{2A} < t$. Without loss of generality, we can also assume that V_{2B} is arbitarily close to V_{2D} for all c, so that the producer's choice of subject matter is effectively between only the "narrow appeal" program type A and the "broad appeal" program type D. Finally, we assume that $V_{1D} < V_{2D}$, but $V_{2D}N_2 < 2V_{1D}N_1$ for all c. The latter inequality ensures that it will never be profitable for the operator to ignore group N_1 in decisions with respect to program D.

A. Limited Channel Cases; Advertiser versus Pay Support

1. Advertiser support, limited channels

Let r be the fixed per capita advertising rate, which is the same for all viewers. Only one channel is available to the operator.

Then:

$$\Pi_A = rN_1 - c_a \qquad (1)$$

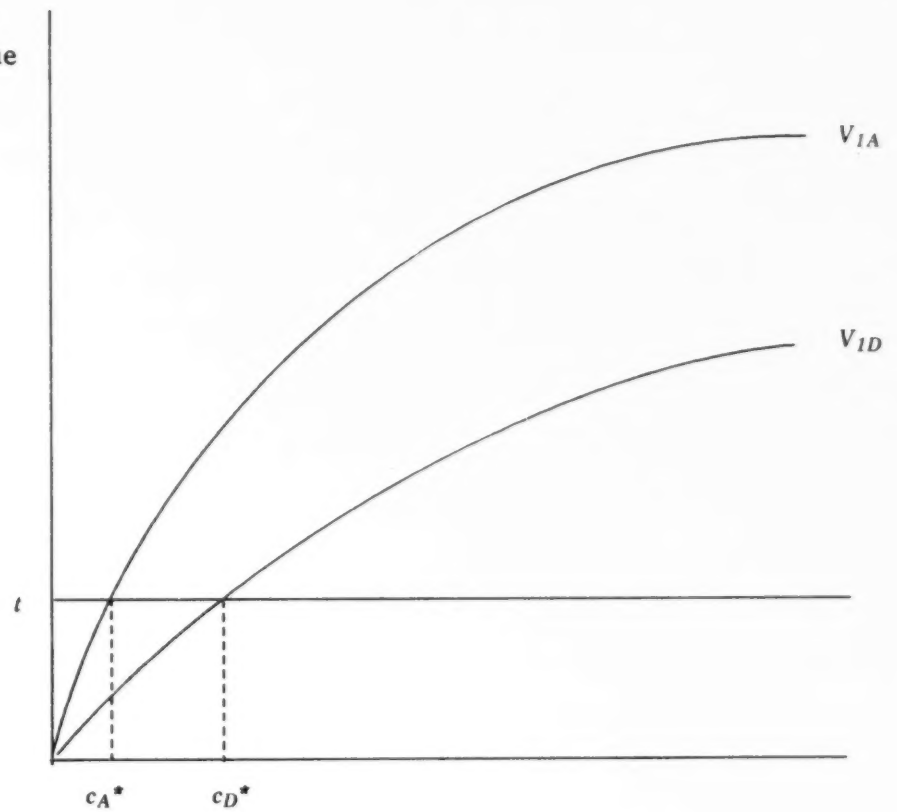
$$\Pi_D = r\left(N_1 + N_2\right) - c_D \tag{2}$$

Program A will be chosen over D if: $\Pi_A > \Pi_D$ at the optimal production investment levels; that is, if $c_A^* < c_D^* + rN_2$, (assuming that $V_D(c_D) > t$ for some c and that profits are positive at c_D^*). Optimal investment level in each program is the minimum level that would be required to just attract viewers away from the alternative, t. That is,

$$V_{1A}\left(c_A^*\right) = V_{1D}\left(c_D^*\right) = t \tag{3}$$

Figure 3 illustrates. The greater the demands for A or D subject matter (*i.e.*, the

Figure 3



greater their value functions), the fewer economic resources the operator needs to

invest in a program of that type and still manage to attract viewers away from the alternative t. Program A, then, will be chosen only if the inherent demand for its subject matter is great enough to permit the operator to produce it cheaply enough to overcome the economies of scale that can be achieved by "buying" N_1 viewers away from the alternative, t, via spending more money (*e.g.*, hiring Harrison Ford) on the broad appeal program, D. It follows that where we observe broad appeal program types like D under pay support, we can expect them to be relatively expensive. Where we observe narrow appeal programs like A, we can expect them to be relatively cheap.

2. Pay support, limited channels

Now consider a system with one channel in which programs are sold via "per program" (pay-per-view) charges.

In this case,

$$\Pi_A = P_A N_1 - c_A \tag{5}$$

$$\Pi_D = P_D\left(N_1 + N_2\right) - c_D \tag{6}$$

To maximize profit, the operator sets $P_A^* = V_A^* - t$, and $P_D^* = V_D^* - t$. That is, price will be set just low enough to attract viewers in each group from the alternative activity, t. Therefore:

$$\Pi_A = \left(V_A^* - t\right)N_1 - c_A \tag{7}$$

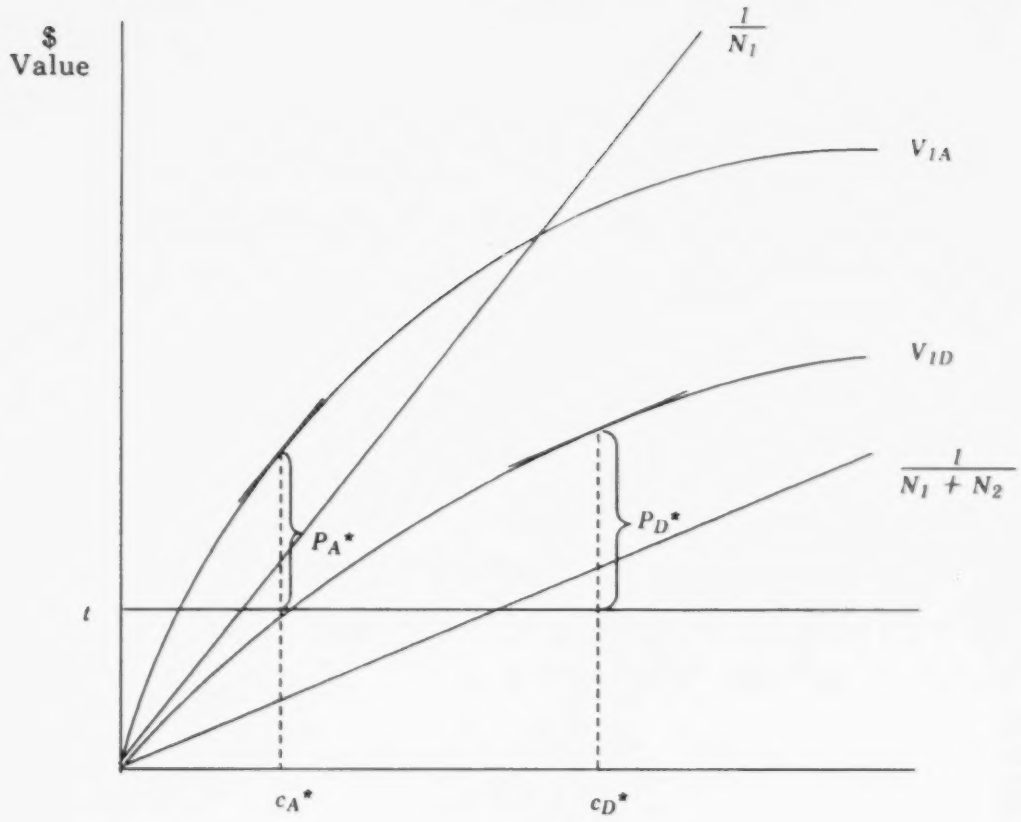
$$\Pi_D = \left(V_D^* - t\right)\left(N_1 + N_2\right) - c_D \tag{8}$$

Maximizing with respect to c_A and c_D:

$$\frac{\partial \pi_A}{\partial c_A} = 1/N_A; \quad \frac{\partial \pi_D}{\partial c_D} = 1/(N_1 + N_2) \tag{9}$$

Figure 4 illustrates. Optimal investment and price of either program is determined by the point at which the slope of its value function is equal to the

Figure 4



Production Investment

inverse of the group size. Pay support for either program type is viable only if $V^* - t > 0$. For both programs, this is a necessary condition for optimal investment under pay support to be greater than in the advertiser support case.

Unlike advertiser support, price support induces optimal investment in both program types to rise as their value functions increase. Whether optimal investment in A is greater than D under pay support depends on the particular shape of the value functions and relative group size. As shown in the Appendix for a specific form of the demand functions, a disproportionately high value function for program A may result in investment expenditure on A exceeding that of D. Again favoring

higher investment in the broad appeal program, however, are the economies of scale to be realized by investing larger amounts in programs which, *ceteris paribus*, reach larger audiences.

3. A Shift from Advertiser to Pay Support: Discrete Production and Demand Functions

The previous results introduce the possibility that a shift from advertiser to pay support will induce the operator not to select a program type having more narrow appeal content, but to increase the level of investment in the broad appeal, "lowest common denominator" program. This case can be illustrated with a simple discrete form of the value functions defined above.

Assume that for both programs A and D, two production levels are feasible: low and high (low = 4, high = 8). The numbers in the Figure 5 matrix indicate price demands of viewers in the respective groups for these alternatives. The assumption of diminishing returns in value to production cost increases is fullfilled in both cases; value increases by half again with each doubling of costs. Further assume that $r=5$; viewers are valued by advertisers at 5 per capita. Also assume that $t = 6$, which means the alternative activity is not a constraint since all programs (except in the case of group N_2's demand for program A), are at least as valuable as t to the viewer. For simplicity we let both N_1 and N_2 be normalized to 1.

Figure 5

Program Choice Model

Program Types		Viewer Groups N_1	N_2
A	High	15	-
	Low	10	-
D	High	9	12
	Low	6	8

The operator has four options for the single channel:

Figure 6

Solutions: Advertiser support, limited channels

Option	Profit level
A, high:	5 - 8 = -3
A, low:	5 - 4 = 1
D, high:	10 - 8 = 2
**D, low:	10 - 4 = 6

D at low cost is the optimum (**). As long as t is not a constraint, it is always more profitable for the monopolist to offer the cheapest possible program that still succeeds in attracting the same viewers.

Under price support, the selections are now be as follows (assuming no price discrimination):

Figure 7

Solutions: Pay Support, limited channels

Option	Profit level
A, high:	15 - 8 = 7
A, low:	10 - 4 = 6
**D, high:	18 - 8 = 10
D, low:	12 - 4 = 8

Profit levels for both types A and D are higher under pay support at both expenditure levels. Program D is still selected, however, in spite of the fact that the per capita value of A increases at a greater rate among the N_1 viewers, because of the economies of scale in continuing to produce D.

A switch from subject D to A would, of course, be possible with a different specification of the value functions. For example, if program A were valued by N_1 viewers at 20 and 30 for low and high investment, respectively, "A, high" would be offered following a shift to pay support, illustrating the tendency for pay support to also encourage more narrow appeal program types.

B. Channel Capacity Expansion; Advertiser versus Pay Support

In general, as capacity grows, the system operator will offer additional programs as long as the marginal program adds more to net revenues than it costs to produce, under either advertiser or pay support. The effects of greater channel capacity on optimal program choice and investment levels can be demonstrated with the general model if we assume that one option for the operator is to use those additional channels to *repeat* programs rather than to produce additional programs.

The intertemporal sequencing of movies and other dramatic programs which we observe on cable is essentially a method of price discrimination practiced by distributors to segment "high value" from "low value" viewers. The operator's incentive to expand production on broad appeal programs--rather than shift to production of narrow appeal programs--by using additional channels to price discriminate in this way can be demonstrated with the general model for the case in which pay-per-view program pricing is available on both channels.

Consider the profit function for program D:

$$\Pi_D = (V_{1D}-t)N_1 + (V_{2D}-t)N_2 - c_D \tag{10}$$

Maximum profit is at the point where $p^* = min(V_D^* - t)$. That is, the operator must set price low enough to attract both groups, with the result that surplus value is lost from group N_1. If the firm is able to price discriminate, however, P_1 and P_2 can be set separately.

Compare optimal production investment in these alternative cases. For the non-price discrimination case, in which D is shown only once to both groups at the minimum price:

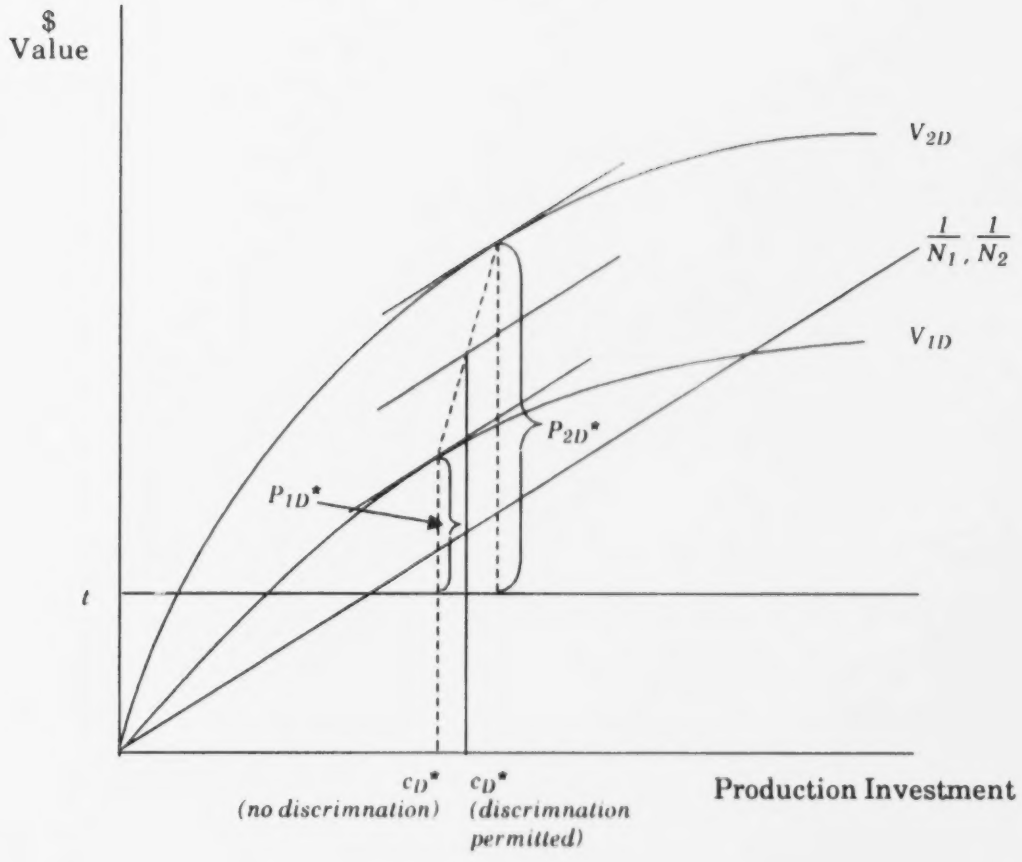
$$\frac{\partial V_{1D}}{\partial c_D} = \frac{1}{N_1+N_2} \tag{11}$$

If price discrimination is permitted, and D repeated on the second channel:

$$\frac{\partial V_{1D}}{\partial c_D}\left(\frac{N_1}{N_1+N_2}\right) + \frac{\partial V_{2D}}{\partial c_D}\left(\frac{N_2}{N_1+N_2}\right) = \frac{1}{N_1+N_2} \tag{12}$$

Optimal production investment is thus higher in the price discrimination case. This result is illustrated graphically for the case of $N_1 = N_2$ in Figure 8. The average of the two value function slopes determines investment level, which must be between the individually set optimum values.

Figure 8



It follows from this model that if the narrow appeal program A were more profitable in the limited channel pay support case by an arbitrarily small margin, then the broad appeal program D would become more profitable at a higher expenditure level if a second channel becomes available for price discrimination.

1. Pay Support, Expanded Channels

The discrete model can be extended to illustrate the potential for using extra capacity to price discriminate with broad appeal program types. In this case, we allow for the possibility of a further increase in program expenditures from that already induced by a shift to pay support with only one channel (Figures 6 and 7

above.) Specifically, we now consider a further potential increase in investment from 8 to 12. This is assumed to increase value for each program at the same diminishing rate as before (specifically, $V_{c+4} = 3/2\,(V_c - V_{c-4})$).

Figure 9

Program Choice Model Extension

Program Types		Viewer Groups N_1	N_2
A:	Very high	18.3	–
	High	15	–
	Low	10	–
D:	Very high	11	14.7
	High	9	12
	Low	6	8

Operator profits for possible combinations are as follows (omitting the low expenditure options, which are dominated):

Figure 10

Solutions:

Expanded capacity, pay support

Channel 1	Channel 2	Profits
A, very high	D, very high	$18.3-12+14.7-12=9.0$
A, very high	D, high	$18.3-12+12-8=10.3$
A, high	D, very high	$15-8+14.7-12=9.7$
A, high	D. high	$15-8+12-8=11$
**D, very high	D, very high	$11+14.7-12=13.7$
D, high	D, high	$9+12-8=13$

The optimal choice is to further increase investment in the mass appeal program, D, rather than to produce the narrow appeal program A.

2. Advertiser Support, Expanded Channels

Intertemporal price discrimination can effectively be acheived with expanded channel capacity without direct pricing under the reasonable assumption that high value viewers have a demand to repeat viewing of the same programs more frequently than do low value viewers. Specifically, let all viewers value watching a repeat of any program at half the value of watching the original.

Under this assumption, consider a transition from one to two channels in the original model of Figure 5 under advertiser support.

The operator's options are:

Figure 12

Solutions: Expanded

Capacity, Advertiser Support

Channel 1	Channel 2	Profits
A, high	D, high	$5-8+5-8=-6$
A, high	D, low	$5-8+5-4=-2$
A, low	D, high	$5-4+5-8=-2$
A, low	D, low	$5-4+5-4=2$
A, high	A, high (repeat)	$5+5-8=2$
A, low	A, low (repeat)	$5+5-4=6$
****D, high**	**D, high (repeat)**	**$5+5+5-8=7$**
D, low	D, low (repeat)	$5+5-4=6$

An expansion of channel capacity under advertiser support thus results in a repeat of the mass appeal program, D, at a higher budget level. The basic reason for this result is that for the low expenditure options, the value of watching a repeat falls below that of the alternative, $t = 6$, for all viewers in every case.

C. Economic Welfare Comparisons

Is society better off or worse off due to a transition from advertiser to pay support and/or from limited to expanded channel capacity? First, we sum producers and consumers surplus in each numerical model and compare.

I. Advertiser support, single channel

Program: D, low expenditure

Consumers surplus: 6 + 8 = 14

Producers surplus: 10 - 4 = 6

Total: 20

II. Pay support, single channel

Program: D, high expenditure

Consumers surplus: 0 + 3 = 3

Producers surplus: 18 - 8 = 10

Total = 13

III. Advertiser support, two channels

Program: D, high expenditure

Consumers surplus: 9 + 12 = 21

Producers surplus: 15 - 8 = 7

Total: 28

IV. Pay support, two channels

Program: D, very high expenditure

Consumers surplus: 0

Producers surplus: 24.5 - 12 = 13.7

Total = 13.7

The comparisons between advertiser and direct pay support (I. vs. II and III. v. IV.) accentuate an element of the classic welfare dilemma of "free" vs. "pay" television. Pay television serves to increase economic welfare because the system is more responsive than advertiser support to audience demands. The reduced total welfare in these discrete models, however, reflects the loss of advertising revenues to the producer, which comes from outside the system. If we assume that this advertising would otherwise be diverted to another vehicle (or that consumers suffer a disutility from the advertising at least as great as these revenues), then a conversion to pay television improves total welfare.

The transition from one to two channels (I. vs. III. and II. vs. IV.) unambiguously increases welfare in both cases. The essential reason for this is that the second channel permits perfect price discrimination by the operator. This mirrors the result of Spence and Owen (1975) that perfect price discrimination results in a more optimal mix of programs, given either monopoly or competition. Our numercial results do not reflect the reality, however, that the value of the product to second

channel viewers must drop if the method of viewer segmentation is to require them to wait for the second exhibition. To this extent, intertemporal release cannot be perfect price discrimination.

While obviously abstract, these welfare comparisons illustrate an additional important point. Given the model of consumer sovereignty on which they are based, (and ignoring the role of advertising revenues from outside the system), the improved responsiveness to viewer demands which cable technology offers, guarantees in itself that consumers will be better off, whether the result be a cornucopia of narrowcasting, or larger budgets for broad appeal programs.

IV. CONCLUSION

These models offer a consistent rationale for the apparent tendency we observe for cable television technology to not only fragment audiences into finer groups through greater availability of narrow appeal programs, but to increase the supply of high budget programs which eventually reach ever larger audiences. They further provide a rationale for the empirical observation that much of the original programming which cable technology has offered appears to be cheap and relatively unattractive, while budgets for "tiered" movies and other drama appear to have inflated.

The assumption throughout this paper of a monopoly operator, while relevant to cable television, restricts comparisons of our results to those of previous models, which were partly concerned with contrasting welfare outcomes of competitive versus monopoly regimes. Expanding our version to a competitive case may help explain the role of program quality competition among cable, broadcast, and other programming sources.

In conclusion, the performance of cable television is ironic in that amid the hopes and expectations for cable as a narrowcaster, the technology has become part of a

process by which some programs, notably feature films, are now able to eventually attract broader audiences and greater revenues than ever before. Cable technology was, to be sure, envisioned by many as a potentially important vehicle for popular movie exhibition. It was widely presumed, however, that if this role of cable were successful, a crushing, if not killing blow would be dealt to the movie theater. Instead, theaters, cable, broadcast television and especially VCR's have all continued to prosper as exhibitors of feature films. The battle, it turns out, has not been for a given sized pie. The benefits from price discrimination made possible by program repetition and intertemporal release have so far left room for everyone.

FOOTNOTES

[1]The data base for this study consisted of a stratified random sample of 16 full days (7 a.m. to 1 a.m.) of programming during the first half of 1986 on 37 nationally-distributed cable networks (26 basic, 11 premium) with comparative data for the public broadcasting system (PBS) and the three commercial broadcast networks. All programming was coded by half-hour segment according to its subject matter (eg, "children's," "public affairs), its origin (eg, "first run," "acquired from U.S. broadcast") and its "format," or mode of presentation (eg, "informational," "dramatic"). A.C. Neilsen Co. generously contributed a corresponding special tabulation of half-hour by half-hour average minute ratings for the 21 commercial networks among the total sample for which audience ratings were retrievable from nationwide metered samples. For PBS-distributed programs, we relied on existing Neilsen records available from PBS.

[2]Ratings data for premium networks were available only for Showtime and HBO, on which dramatic programming accounted for 89% of hours and 91% of viewing.

[3]The total residual audience recorded by Neilsen for all basic cable programming other than that on the 16 networks which were individually rated accounted for 6.4% of all basic cable veiwing. Unrated hours on ll additional unrated networks accounted for 37.6% of our sample's program hours. If these unrated hours are taken as the base over which the Neilsen residual is spread, average rating for unrated program hours would be .15.

[4]Fifty-six percent of basic cable viewing in the 1986 sample was for original programming, which would yield an estimate of $323 spending for original production programming.

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APPENDIX: A SHIFT FROM ADVERTISER TO PAY SUPPORT: CONTINUOUS PRODUCTION AND DEMAND FUNCTIONS

The tradeoffs between program diversity and the levels of production investment can be demonstrated for a simple demand function in the context of the general program choice model of Figure 1.

Let

$$V_{1A} = a_1 C_A^{\gamma} \qquad V_{2A} = a_2 C_A^{\gamma} \tag{1A}$$

$$V_{1B} = b_1 C_B^{\gamma} \qquad V_{2B} = b_2 C_B^{\gamma}$$

$$V_{1D} = d_1 C_D^{\gamma} \qquad V_{2D} = d_2 C_D^{\gamma}$$

where $0<\delta<1$. "δ" represents the elasticity of viewer demand w.r.t. production investment. Also following the simplifying assumptions of the text discussion:

$$a_2, b_1 < t \tag{a}$$

$$a_1 > b_2 > d_2 > d_1 > t \tag{b}$$

$$a_1 N_1 > b_2 N_2 \tag{c}$$

$$d_2 N_2 > 2\, d_1 N_1 \tag{d}$$

Assumption (c) insures that A dominates B for all c, so the operator's decision is effectively only between A and D. Assumption (d) ensures that the operator will not choose to ignore N_1 in decisions regarding program D and also that in the absence of price discrimination, d_1 is the constraining parameter w.r.t. D.

I. ADVERTISER SUPPORT, ONE CHANNEL

$$\Pi_A = r N_1 - a_1 C_A^{\gamma} \tag{2A}$$

$$\Pi_D = r\left(N_1 + N_2\right) - d_1 C_D^{\gamma} \tag{3A}$$

The operator maximizes w.r.t. production investment, yielding:

$$C_A^* = \left(\frac{\gamma}{a_1} \right)^{\frac{1}{\gamma}} \tag{4A}$$

$$C_D^* = \left(\frac{\gamma}{d_1} \right)^{\frac{1}{\gamma}} \tag{5A}$$

Substitution of (4A) and (5A) into (2A) and (3A) yields:

$$\Pi_D^{*(ADV)} - \Pi_A^{*(ADV)} = d_1 - \frac{\iota}{\left| \left(\frac{\gamma}{a_1} \right)^{\frac{1}{\gamma}} + rN_2 \right|^{\gamma}} \tag{6A}$$

This function is increasing in d_1, γ, r and N_2, and decreasing in a_1 and ι. That is, the greater is d_1 and the smaller is a_1, the higher the potential profit from D. D is also favored by a high elasticity of demand w.r.t. production investment, γ, a larger potential audience for D (*i.e.*, $N_1 + N_2$), and a higher advertising rate r. These results explicitly demonstrate the importance of economies of scale inherent in selecting the broad appeal program. Conversely, the greater is the value of the alternative activity, ι, the less the advantage that can be taken of these scale economies.

Further, note that since $a_1 > d_1$ by assumption, $c_D^* > c_A^*$ for all γ and ι.

II. PAY SUPPORT, ONE CHANNEL

$$\Pi_A = P_A N_1 - a_1 C_A^{\gamma} \tag{7A}$$

$$\Pi_D = P_D \left(N_1 + N_2 \right) - d_1 C_D^{\gamma} \tag{8A}$$

Setting $P^* = V^* - \iota$, and maximizing w.r.t. production investment:

$$C_A^* = \left(a_1 \gamma N_1 \right)^{\frac{1}{1-\gamma}} \tag{9A}$$

$$c_D^* = \left| d_1 \gamma \left(N_1 + N_2 \right) \right|^{\frac{1}{1-\gamma}} \qquad (10A)$$

Substitution yields:

$$\Pi_D^{*(PAY)} - \Pi_A^{*(PAY)} = d_1 - \left| \left(\frac{N_1}{N_1 + N_2} \right)^{\frac{1}{1-\gamma}} a^{\frac{1}{1-\gamma}} + \frac{\iota N_2}{f\left(\gamma\right)\left(N_1 + N_2\right)^{\frac{1}{1-\gamma}}} \right|^{1-\gamma} \qquad (11A)$$

where

$$f\left(\gamma\right) = \gamma^{\frac{\gamma}{1-\gamma}} - \gamma^{\frac{1}{1-\gamma}} > 0$$

The expression in (11A) is increasing in d_1, γ, and N_2, and decreasing in a_1, ι and N_1. Analogously to the advertiser support cases, higher values of D versus A, as represented by a_1 and d_1, favor program D. Also analagous are the economies of scale which can be realized from D as γ and N_2 increase, and as ι and N_1 decrease.

With respect to production investment, the condition for $c_A^* > c_D^*$ is $a_1 > (N_1 + N_2/N_1) d_1$. The value of program A, that is, must be more that proportionatelygreater than for D to compensate for N_1's disadvantage in audience size.

III. COMPARISON OF PAY AND ADVERTISER SUPPORT

Under what circumstances will a shift occur in the choice between the broad appeal and narrow appeal program, due to a switch from advertiser to pay support? We are especially interested in cases when $\Pi_D^{(ADV)} \leq \Pi_A^{(ADV)}$, but $\Pi_D^{(PAY)} > \Pi_A^{(PAY)}$. Letting (6A) above = 0 and substituting the resulting expression for d_1 into (11A) yields a complex expression which is not readily simplified.

The comparison can be shown more easily by dropping assumption (c) above and considering the operator's choice to be between offering A *and* B vs. D only. For the advertiser support case, this yields:

$$\Pi_D^{*(ADV)} - \Pi_A^{*(ADV)} = d - \left(a_1^{-\frac{1}{\gamma}} + b_2^{-\frac{1-\gamma}{\gamma}} \right) \qquad (12A)$$

For the pay support case:

$$\Pi_D^{*(PAY)} - \Pi_A^{*(PAY)} = d_1 - \left| \frac{(a_1 N_1)^{\frac{1}{\gamma}} + (b_2 N_2)^{-\frac{1-\gamma}{\gamma}}}{N_1 + N_2} \right| \tag{13A}$$

Both of the right hand expressions are increasing in d_1, and γ, but decreasing in a_1 and b_2. That is, the relative viability of A plus B increases with a shift upward in their value functions, as represented by the parameters a_1 and b_2. But the higher is the elasticity of audience demand w.r.t. production investment, the greater the economies of scale which can be realized via the broad appeal program.

If we now simplify by letting $N_1 = N_2$ and $a_1 = b_2$, we obtain:

$$\Pi_D^{(ADV)} - \Pi_A^{(ADV)} = \Pi_D^{(PAY)} - \Pi_A^{(PAY)} = d_1 - \frac{a_1}{2^\gamma} \tag{14A}$$

The operator is just indifferent, that is, between A plus B vs. D in both the advertiser and pay support cases. This result shows that if a D program is marginally more profitable to produce than A plus B given advertiser support, then D will also be marginally more profitable to produce under pay support, only at a higher expenditure level. Production cost inflation, not a shift to narrow appeal subject matter, is the sole result of the introduction of direct pricing.